CLAIMS

1. A portable instrument for measuring parameters of optical signals propagating bi-directionally in an optical transmission path (16/9) between first (10) and second (14/9) elements at least one of which will not transmit its optical signals if continuity of the path is not maintained, the instrument being characterized by first and second connector means (22, 24) for connecting the instrument into the optical transmission path in series therewith, coupler means (32) having first and second ports (28, 30) connected to the first and second connector means, respectively, so that a path therebetween within the coupler completes the optical transmission path, a third port (36) for outputting a portion of each optical signal received via the first port (28) and a fourth port (34) for outputting a portion of each optical signal received via the second port (30), detection means (38, 42, 44) coupled to the third and fourth ports for converting the optical signal portions into corresponding electrical signals, and processing means (46) for processing the electrical signals to provide desired measurement values, and output means (60) for indicating measured parameters.

2. An instrument according to claim 1, characterized in that, where one of the elements transmits its optical signals at two different wavelengths, the corresponding optical signal portion comprises two parts having said different wavelengths, respectively, and the instrument further comprises means (40, 64, 66;68) for distinguishing the optical signal parts according to wavelength, the detection means and processing means detecting and processing the two different signal parts separately.

3. An instrument according to claim 2, characterized in that the detection means comprises two detectors (42, 44), each for detecting a respective one of the optical signal parts.

4. An instrument according to claim 2 or 3, characterized in that said distinguishing means comprises a splitter (40) for splitting said optical signal

portion into said two parts and two bandpass filters (64,66) each centered around a respective one of said different wavelengths, each coupled to a respective one of output ports of the splitter (40).

5. An instrument according to claim 2 or 3, characterized in that said distinguishing means comprises a wavelength discriminator (68) coupled between the coupler (32) and the detection means.

6. An instrument according to any one of claims 1 to 5, characterized in that, where the optical signals are analog, the processing means (46) is arranged to extract the time-averaged optical power of the signal.

7. An instrument according to any one of claims 1 to 5, characterized in that, where the optical signals comprise bursts alternating with lulls, the processing means (46) is arranged to extract the optical power of the bursts.

8. An instrument according to any one of claims 1 to 5, characterized in that, where the optical signals are digital signals, the processing means (46) is arranged to the extract the optical power of the bursts averaged over the duration of each burst.

9. An instrument according to any one of claims 1 to 8, characterized in that the processing means (46) comprises custom circuitry.

10. An instrument according to any of claims 1 to 8, characterized in that the processing means (46) comprises a suitably-programmed microcomputer

11. An instrument according to any one of claims 1 to 10, characterized in that said output means comprises display means (60) coupled to said processing means (46) for displaying the parameter measurements.

12 A method of measuring parameters of optical signals propagating bi-directionally in an optical transmission path, at least one of the elements not transmitting its optical signals if continuity of the transmission path is not maintained, the method comprising the steps of

(i) connecting into the optical transmission path first and second ports of a coupler so that a path through the coupler between the first and second ports is in series with the optical transmission path and conveys said bi-directional signals therebetween,

(ii) detecting at a third port of the coupler a portion of a said optical signal propagating in one direction in the path and providing a corresponding first electrical signal;

(iii) detecting at a fourth port of the coupler a portion of a said optical signal propagating in the opposite direction in the path and providing a corresponding second electrical signal; and

(iv) processing said first and second electrical signal to provide desired measurements.

13 A method according to claim 12, <u>characterized in that</u>, where one of the elements transmits its optical signals at two different wavelengths, the corresponding optical signal portion is divided into two parts having said different wavelengths, respectively, the optical signal parts are distinguished according to wavelength, and the two different signal parts are detected and processed separately

14. A method according to claim 13, <u>characterized in that</u> the detection step uses two detectors (42, 44), each to detect a respective one of the optical signal parts.

15. A method according to claim 13 or 14, <u>characterized in that</u> said distinguishing step is performed by splitting said optical signal portion into said two parts and bandpass filtering the parts using bandpass filters (64,66) each centered around a respective one of said different wavelengths.

16. A method according to claim 13 or 14, characterized in that said distinguishing step uses a wavelength discriminator (68) to split said portion into said parts.

17 A method according to any one of claims 12 to 16, characterized in that, where the optical signals are analog, the detection and processing derives the time-averaged optical power of the signal.

18. A method according to any one of claims 12 to 16, characterized in that, where the optical signals comprise bursts alternating with lulls, the detection and processing derives the optical power of the bursts .

19. A method according to any one of claims 12 to 16, characterized in that, where the optical signals are digital signals, the detection and processing derive the optical power of the bursts averaged over the duration of each burst.

20. A method according to any one of claims 12 to 19, characterized in that the processing is performed using custom circuitry.

21. A method according to any of claims 12 to 19, characterized in that the processing is performed using a suitably-programmed microcomputer.

22. A method according to any one of claims 12 to 21, further characterized by the step of displaying the parameter measurements.

23 A method according to any one of claims 12 to 22, characterized in that the measurements are performed upon optical signals propagating bi-directionally in an optical transmission path between network elements in a passive optical network.

AMENDED CLAIMS

received by the International Bureau on 15 February 2005 (15.02.05): original claims 1-23 have been replaced by amended claims 1-27 (6 pages).

1. A portable instrument for measuring parameters of optical signals propagating concurrently in opposite directions in an optical transmission path (16, 16/1,..., 16/9) between two elements (10, 14/1...14/9), at least one (14/1...14/9) of the elements being operative to transmit a first optical signal (S1) only if it continues to receive a second optical signal (S2) from the other (10) of said elements, the instrument being characterized by first and second connector means (22, 24) for connecting the instrument into the optical transmission path in series therewith, and means (32, 38, 46) connected between the first and second connector means for propagating at least said second optical signal (S2) towards said at least one (14) of the elements, and measuring said parameters of said concurrently propagating optical signals (S1, S2).

2. A portable instrument according to claim 1, characterized in that the propagating and measuring means (32, 38, 46) provides an optical signal path between the first and second connector means (22, 24) for conveying at least said second optical signal (S2).

3. A portable instrument according to claim 2, characterized in that the propagating and measuring means (32, 38, 46) comprises:

coupler means (32) having first and second ports (28, 30) connected to the first and second connector means (22, 24), respectively, to provide said optical signal path to convey said first (S1) and second (S2) optical signals in opposite directions between said first and second connector means (22, 24), and a third port (34) for supplying a portion of said first optical signal (S1),

detection means (38; 38, 42; 38, 42, 44) for converting at least the first optical signal portion into a corresponding electrical signal, and

measuring means (46) for processing the electrical signal to provide an indication of said measured parameters.

4. An instrument according to claim 3, characterized in that the coupler means (32) has a fourth port (36) for supplying a portion of said second optical signal (S2), the detection means (38; 38, 42; 38, 42, 44) also converting the second optical signal portion into a corresponding second electrical signal, and the measuring means (46) processing both of the electrical signals to provide desired measurement values of parameters for each of the counter-propagating signals.

5. An instrument according to claim 1, 2, 3 or 4, characterized in that, where said one of the elements (14/1,..., 14/9) also receives via said optical transmission path a third optical signal (S3) at a different wavelength from that of said second optical signal (S2), the propagating and measuring means further comprises means (40, 44, 52, 58; 44, 58,68) for measuring parameters of the third optical signal (S3).

6. An instrument according to claim 4, characterized in that, where said one of the elements (14/1,..., 14/9) also normally receives via the optical transmission path a third optical signal (S3) at a different wavelength to that of said second optical signal (S2), the propagating and measuring means further comprises a splitter (40) connected to the coupler means (32) for splitting a corresponding optical signal portion into two parts, each comprising portions of both the second and third optical signals, and filter means (64, 66) coupled to the splitter (40) for separating the two parts according to wavelength before supplying same to said detection means (38, 42, 44).

7. An instrument according to claim 4, characterized in that, where said one of the elements (14/1,..., 14/9) also normally receives via the optical transmission path a third optical signal (S3) at a wavelength different from that of said second optical signal (S2), said propagating and measuring means comprises a wavelength discriminator (68) connected to the coupler (32) for separating the second and third optical signals (S2, S3) according to wavelength before supplying same to said detection means (38, 42, 44).

8. An instrument according to any of claims 1 to 7, characterized in that the measuring means comprises a separate detector (38, 42, 44) for each of the measured optical signals.

9. An instrument according to any one of claims 1 to 8, characterized in that, where one of the optical signals is analog, the measuring means (46) is arranged to extract the time-averaged optical power of the signal.

10. An instrument according to any one of claims 1 to 8, characterized in that, where one (S1) of the optical signals comprises bursts of digital data alternating with lulls, the measuring means (46) is arranged to extract the average of the optical power averaged over the duration of the individual bursts.

11. An instrument according to any one of claims 1 to 10, characterized in that the measuring means (46) comprises custom circuitry.

12. An instrument according to any of claims 1 to 10, characterized in that the measuring means (46) comprises a suitably-programmed microcomputer.

13. An instrument according to any one of claims 1 to 12, characterized in that said measuring means further comprises display means (60) for displaying the parameter measurements.

14. A method of measuring parameters of at least one of optical signals propagating concurrently in opposite directions in an optical transmission path (16, 16/1,..., 19/9) between two elements (10, 14/1...14/9), at least one (14/1...14/9) of the elements being operative to transmit a first optical signal (S1) only if it continues to receive a second optical signal (S2), the method being characterized by the steps of:

connecting first and second connector means (22, 24) of an instrument into the optical transmission path in series therewith,

using the instrument to propagate at least said second optical signal (S2) towards said at least one (14) of the elements, and

measuring said parameters of said concurrently propagating optical signals.

15. A method according to claim 14, <u>characterized in that</u> the instrument provides an optical signal path between the first and second connector means (22, 24) for at least said second optical signal (S2).

16. A method according to claim 15, <u>characterized in that</u> the instrument has a coupler means (32) having first and second ports (28,30) connected to the first and second connector means (22, 24), respectively, to provide said optical signal path for conveying said first (S1) and second (S2) optical signals in opposite directions between said first and second connector means (22, 24), and a third port (34) for a portion of said first optical signal (S1) propagating in said optical signal path, the method comprising the steps of:

extracting said portion of said first optical signal (S1) from said third port of the coupler means,

converting the first optical signal portion into a corresponding first electrical signal, and

processing the first electrical signal to provide an indication of said measured parameters.

17. A method according to claim 16, <u>characterized by the steps of</u>

extracting from a fourth port (36) of the coupler (32) a portion of said second optical signal (S2) propagating in the optical signal path;

converting the second optical signal portion into a corresponding second electrical signal; and

processing said first and second electrical signals to provide the desired parameters for each of the counter-propagating optical signals.

18. A method according to claim 14, 15, 16 or 17, characterized in that, where said one of the elements (14/1,..., 14/9) also receives via the optical transmission path a third optical signal (S3) at a wavelength different from that of said second optical signal (S2), the measuring step also measures parameters of the third optical signal (S3).

19. A method according to claim 17, characterized in that, where said one of the elements (14/1,..., 14/9) also receives via the optical transmission path a third optical signal (S3) co-propagating with the said second optical signal (S2) at a wavelength different from that of the said second optical signal (S2), the measuring step includes the steps of splitting a portion of the co-propagating optical signals into two parts, each comprising portions of the second and third optical signals (S2, S3), separating each of the two parts according to wavelength, converting said parts into said second electrical signal and a third electrical signal, respectively, and also processing the third electrical signal to obtain parameters of the third optical signal (S3).

20. A method according to claim 17, characterized in that, where said one of the elements (14/1,..., 14/9) also receives via the optical transmission path a third optical signal (S3) co-propagating with the said second optical signal (S2) at a wavelength different from that of the said second optical signal (S2), said measuring step employs a wavelength discriminator (68) connected to the coupler (32) for splitting a portion of the co-propagating optical signals into two parts each corresponding to a respective one of the second and third optical signals, , converting the parts to said second electrical signal and a third electrical signal, and also processing the third electrical signal to obtain parameters of said third optical signal (S3).

21. A method according to any one of claims 14 to 20, characterized in that the detection step uses a separate detector (38, 42, 44) for each of the measured optical signals.

22. A method according to any one of claims 14 to 21, characterized in that, where one of the optical signals is analog, the detection and processing derives the time-averaged optical power of the signal.

23. A method according to any one of claims 14 to 21, characterized in that, where one (S1) of the optical signals comprises bursts of digital data alternating with lulls, the detection and processing derives the average of the optical power averaged over the duration of the individual bursts.

24. A method according to any one of claims 14 to 23, characterized in that the processing is performed using custom circuitry.

25. A method according to any of claims 14 to 23, characterized in that the processing is performed using a suitably-programmed microcomputer.

26. A method according to any one of claims 14 to 25, further characterized by the step of displaying the parameter measurements.

27. A method according to any one of claims 14 to 26, characterized in that the measurements are performed upon optical signals propagating concurrently in opposite directions in an optical transmission path between network elements in a passive optical network.